

AN INNOVATIVE DESIGN OF AIR FILTER IN DIESEL ENGINES OF THE TRACTORS

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ABSTRACT

The escape of small particles in the IC engine combustion chamber will cause wear of the cylinders and pistons and that led to reduce the engine performance and its lifetime service. In this study the air filter system was improved by the increase the length of air sleeve and add another paper filter at the top. The life service of the three types of air filtering systems was investigated by collecting a data air filter replacing after achieving a different of agricultural applications including (plowing, soil straightening, seeding, pesticides, herbicides and harvesting). The innovative design shown the best performance and long life service. Moreover, the air filtering system oil bath with centrifugal and paper filter provided long life service three times better than the single air filter.

KEYWORDS: Design, Air Filter, Agricultural Operations, Operation Distance & Filter Types

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INTRODUCTION

The internal combustion engines' life service depends on several factors. The wear on engine parts consider a significant one of these factors. The common wear reason is the atmospheric dust that escapes from the filter(s) into the combustion chamber of the engine or carried to it with the oil lubrication (Toma, 2016). Vehicles' air filters are usually made of felt or cellulose paper. There are several materials are used in different types of dry air filters including (paper, gauze, foam, cotton, stainless steel). Moreover, there are other kinds of air filter such as oil bath filter and water bath filter. These are placed in cylindrical or prismatic attachments, depending on the available space and are specially designed for frequent maintenance activities. If an internal combustion engine was operated without the air filter that would lead to be subject to wear 10 times faster compared with an engine which working with air filter (Herbert, 1991). The regular maintenance, including removing the solid particles using high pressure air flow or replace the filter represents an important sign in engine service life. With the passage of time, the hard particles will accumulate in the filter causing decline in the intake air flow rate of the engine and consequently will affect the engine efficiency (Bugli, 2000). The air filter marketplace is focused by the performance requirements for engine air induction systems such as, high dust-holding capacity, low flow restriction high fractional efficiency, long life service- designs, small, compact components, integrated air intake & silencing system, stable air intake systems with non-evaporative emissions, exclusive designs, ideal volume to be fitted into the available space (Jhon, 2016). Acceleration performance on vehicles increasing with clean air filter (Norman, 2009). Engine lifetime, IC engine emission and fuel consumption depend on the air filter system design and its performance (Petal, et.al, 2013). In tractors, air filter(s) usually, put in a high tube to reduce the amount of dust or soil particles that can move into the engine. Some brands of agricultural tractors use the dry air filter and other use a combined air filter (dry air filter and oil or water bath filter) in addition to centrifuges that can be

helped to dispose the dust particles. The dust content of the air averages 1 mg/m^3 on paved roads, however, the dust content can be as high as 40 mg/m^3 on unpaved roads and on construction sites. In other words– depending on operating conditions and the roads – a medium-sized engine can draw in up to 50 g of dust over 1000 km (Gailis, 2011). The size of dust particles varies from 0.01 mm till 2 mm (Horst, 2000)

This research aims to improve the air filtering system design in agricultural tractors to provide a better performance for different kinds of farming processes.

MATERIALS AND METHODS

The tractors working on paved road and farms for several purposes. In the farms the tractors are used to achieve many farming operations, including (plowing, soil straightening, seeding, pesticides, herbicides and harvesting). In each of these processes the amount of dust will be varied according to many factors such as the moisture contentions of soil, types of crops and environmental conditions. In this case study the air filter duct was modified by increase its length to be one meter higher than the top of the diesel engine. The goal of this attempt is to avoid the high density of dust that usually be around the tractor wheels with 50-120cm high from the earth. Moreover, additional paper filter was added. So the air filtering system has been a composite filter that consists of (paper air filter at the top, oil bath with centrifugal and second paper filter) as shown in figure 1.

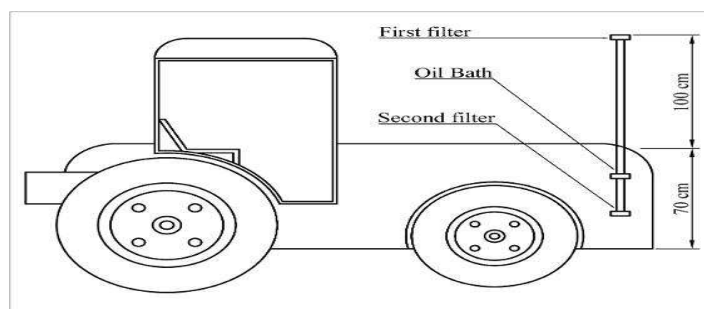


Figure 1: The Composite Filter System with Long Sleeve

The data of three different air filtering systems in agricultural tractors {a) one paper filter, b) air filter and oil bath with centrifugal, c) the composite system} were collected from several workshops in many places in Iraq (Baghdad, Babylon and Diyala). These data on filters placement in maintenance target after achieving different agricultural processes.

RESULTS AND DISCUSSIONS

The data about life service of three types of air filters were collected as working hours because the majority of maintenance schedules for agricultural mechanics and equipment depends on the number of working hours. The reason of that because sometimes the agricultural equipment and mechanics are working at the same place (without moving on earth). The averages of the working hours were considered. In the soil straightening process shown the less air filters' life service for three types of air filtering systems that can be justified due to the high amounts of soil particles and plant residues that spatter during this process. It is clear to see the composite filter system provides longer life service in the different agricultural practices due to its location in one meter high at the IC engine top cover, at this place the plant residues and the soil particles will be less quantity there for, the possibility of clogging will be at the smallest rate. The (air filter with centrifugal and oil bath) system shown three times life service compare with single air filter. This phenomena were interpreted due to the power of centrifugal and the ability of the oil to non-stick with impurities.

Table 1: The Life Service for different Filter Types (Working Hours) at Verity Agricultural Process

Agricultural Process Filter Types	Paved Roads	Plowing	Straightening	Seeding	Pesticides, Herbicides	Harvesting
Signal Air Filter	3000	1250	1000	1700	1500	3500
Air Filter with Oil Bath	9000	4000	3000	5000	5000	4500
Double air filter with Oil Bath	11500	6500	5250	8000	6800	7000

CONCLUSIONS

The composite air filter that was consisted from paper air filter in the top of the 1m duct above the diesel engine cover with centrifugal plus oil bath and second air filter represented the best performance in many of agricultural applications. The air filter system with only one air filter and oil bath and centrifugal shown three times performance better than the single air paper filter. Additional research can be achieved by replacing a stainless steel mesh at the top of the sleeve instead of the first filter.

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